DIXON MARINE CONSULTING LTD

Offshore Personnel Transfer Technique Evaluation

SWINGROPE TRANSFER

January 2019

Technique Evaluation including Generic Risk Assessment.

Dixon Marine Consulting Ltd

11 White Hart St
Aylsham, Norfolk
NR11 6HG

+44(0)1263 733530
www.dmcltd.com
d.dixon@dmcltd.com

PRESENTED TO

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PRESENTED BY

Dixon Marine Consulting Ltd

11 White Hart St
Aylsham
Norwich
Norfolk
NR11 6HG

Contact: David Dixon
Tel. +44 (0) 1263 733530
Fax. +44 (0) 1263 733730
E-mail:
d.dixon@dmcltd.com

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Appendix 3:	LTI reports and safety alerts (Collated)
Appendix 4:	Guidance Notes, Procedures (Collated)
Appendix 5:	Swing-rope Operations Video Clips.
Appendix 6:	Seatex MRU 5 Marine Motion Sensor Data Sheet.
Appendix 7:	General Acoustics Seastate / Sea Level Monitoring System.
Appendix 8:	Jason’s Cradle Personnel Retrieval System Fact Sheet.
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Appendix 10:	Bow Tie Risk Assessment Briefing Note
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1 PREAMBLE

1.1 Purpose

The purpose of this study document is to provide an objective evaluation of the 'Swing-rope' personnel transfer technique, which remains a widely used means of transferring personnel from crew-boats to worksites and vice versa offshore. The aim of that evaluation is to provide offshore contractors, operators, vessel owners, and safety specialists with an independent assessment of the technique based on a generic hazard identification and risk assessment, so as to be able to compare the technique to other personnel transfer options available to them, and also as a guide to the risks involved in this mode of personnel transfer, and means of mitigating such risks.

1.2 Scope

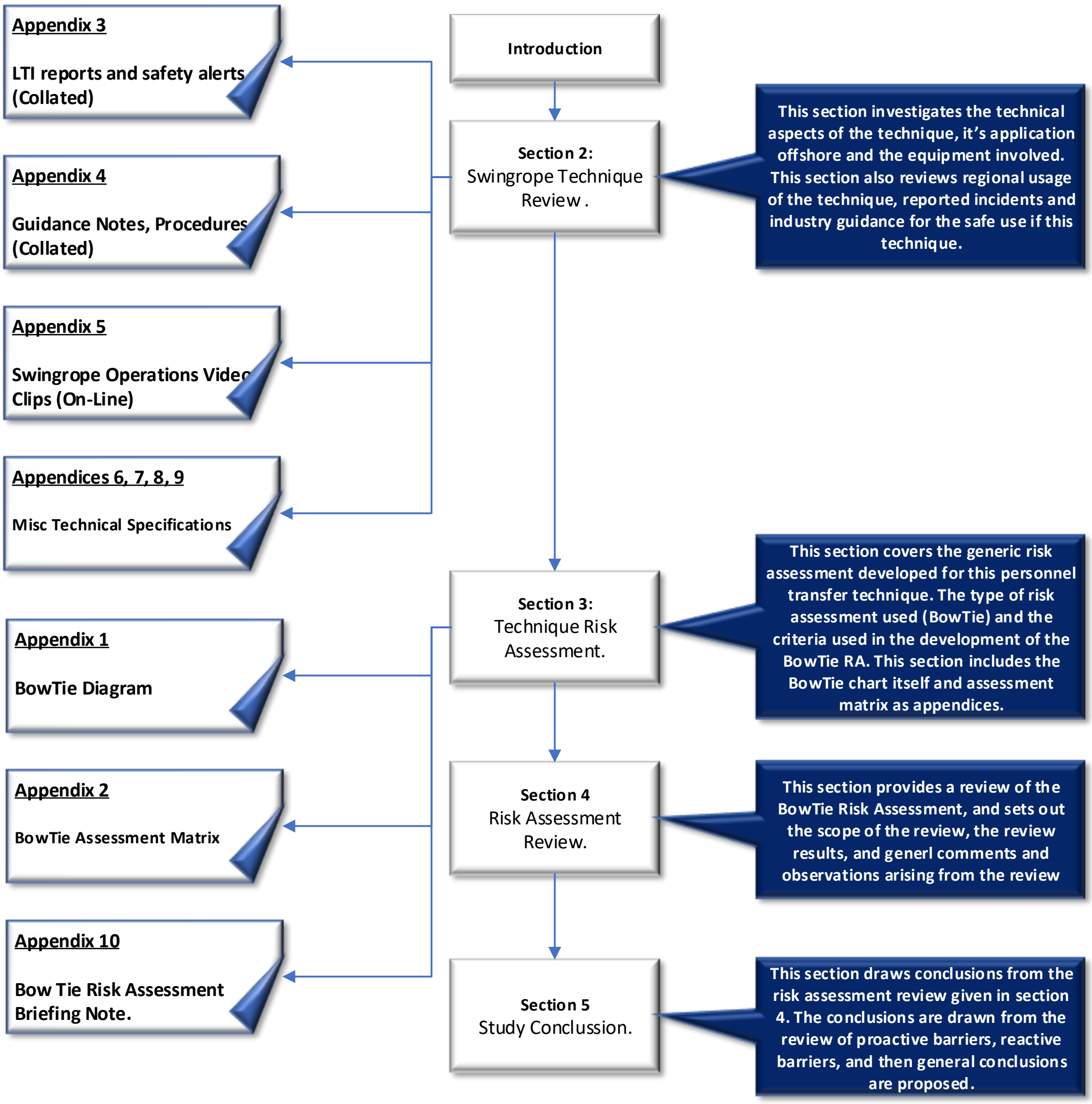
The scope of this offshore personnel transfer technique evaluation is Swing-rope transfer, primarily from crew-boats to fixed installation boatlandings and vice-versa, but also including transfer to and from accommodation work vessels. This evaluation has focused on routine crew-change transfer activities only and has not evaluated the technique as a means of emergency evacuation or escape. Furthermore, this evaluation document does not seek to make a qualitative comparative analysis of swing-rope transfer with alternative offshore transfer techniques.

1.3 Background

DMC Ltd is a marine consulting and shipbroking firm, with a specialist focus on project support vessels and activities in the offshore oil and gas market. As such, the company is required to provide guidance on the procurement of offshore support vessels, including accommodation vessels and crew-boats, and also guidance on the safe and efficient management of these marine assets. This involves access and egress to these craft and offshore worksites, and this in turn has involved DMC with a variety of consulting briefs covering a broad range of access / egress methods from simple 'bump & jump' techniques, through to large, motion compensated gangway systems. It has been apparent when researching the variety of offshore personnel transfer methods that whilst some techniques such as helicopter transfer, basket transfer and motion-compensated gangways have a wealth of statistical data and risk assessment information available, swing-rope transfer does not, and as part of two recent consulting projects DMC has found it necessary to research the technique, make a generic hazard identification and risk assessment, and from that process derive an objective evaluation of the process. This document has consolidated the results of those separate consulting projects into this personnel transfer technique evaluation and generic risk assessment document.

1.4 Executive Summary

The following chart summarises the contents of this swing-rope technique evaluation and risk assessment report, together with appendices relating to each section.



1.4.1 Section 2 - Swing-rope Technique Review.

This personnel transfer technique evaluation and risk assessment document is structured so as to review the technique itself in section 2. This includes offshore applications, the hardware involved, a review of incidents related to swing-rope transfers, and industry guidance for the safe use of the technique. This technique review is not intended to be an exhaustive guide to the technique, but is aimed at providing an overview with sufficient detail to put the BowTie Risk assessment in context.

1.4.2 Section 3 - Technique Risk Assessment.

The risk assessment itself is discussed and set out in section 3. The risk assessment format used was BowTie, processed using BowTie XP software. Due to the size of the BowTie diagram and the assessment matrix, each have been given as separate appendices (1 and 2 respectively). This section sets out the process used to develop the BowTie, the criteria and degree of granularity used. For those not familiar with the BowTie risk assessment technique, a basic guide to the method is given in appendix 10. For those not needing an in-depth risk assessment, and who simply require a review of the process and conclusions, and those not intending to use this report as a generic base for a project-specific risk assessment, then section 3 could be skipped, and the document continued at section 4. In addition to forming the basis for the evaluation of the technique, the BowTie Risk assessment given in this section represents a generic hazard identification and risk assessment basis for a project-specific application.

1.4.3 Section 4 – Risk Assessment Review.

The results of the BowTie risk assessment detailed in section 3, are assessed in more detail in section 4. This risk assessment review includes analyses of barrier profiles and their effectiveness, general comments and observations regarding the technique, and challenges in terms of maintaining a safe system of work to ALAP standards.

This in-depth risk assessment analysis highlights the quantity of threats to a safe system of work, the extensive range of proactive barriers required to mitigate risk, together with the complexity of managing these barriers. Similarly, the severity of consequences and the fragility of many of the reactive barriers proposed is examined.

The inevitable presence of multiple safety management systems involved in swing-rope transfer operations and the unpredictable nature of several of the threats is also highlighted, which adds to the complexity of maintaining a safe system of work and detracts from the efficiency and viability of this personnel transfer technique.

1.4.4 Section 5 – Study conclusions.

In section 5, conclusions are drawn from the risk assessment review. Both the threat side of the BowTie and proactive barriers, and the consequence side and reactive barriers are considered, culminating in general, objective conclusions regarding this personnel transfer technique. The conclusions include:

- The observations that in the context of general industrial & occupational safety/risk management norms, the concept of swing-rope transfer is itself an extraordinary and high-risk technique.
- The observation that the quantity of threats, severity of consequences and the extensive range of proactive and reactive barriers required to mitigate risk to ALAP call into question the efficiency of the technique. i.e. the protection / productivity balance is heavily weighted on the 'protection' side if a safe system of work is to be maintained.
- The observation that as risk management (Loss Prevention) systems become more sophisticated and widespread in the offshore oil & gas arena, and the availability of cost-efficient, safer alternative personnel transfer techniques increases, then the trend of prohibition of this technique will inevitably increase, to a point where it will no longer be used.

2 SWING-ROPE TECHNIQUE REVIEW

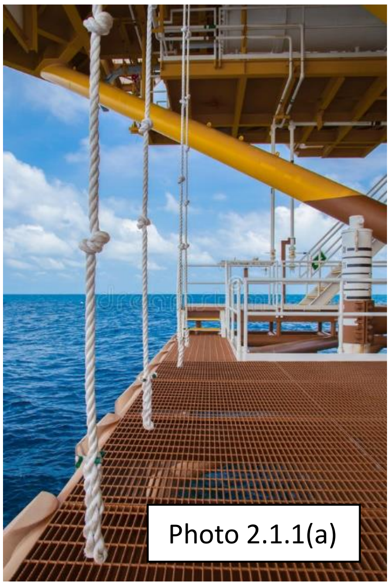
2.1 Technique Overview.

Personnel transfer by swing-rope remains a widely use technique in the offshore oil and gas market, predominantly in regions where benign metocean conditions prevail, and where alternative means of transfer such as basket transfer or helicopter may not be available. E.g. on normally unmanned installations (NUI) and accommodation vessels. The technique involves positioning the personnel transportation vessel (typically a crew-boat) stern-to a personnel landing stage which is specially equipped with swing-ropes. Whilst the vessel maintains as close-station as possible, personnel swing on specially designed ropes from either the crew-boat to the destination landing stage or vice versa, depending on the direction of transfer (see Photo 2.1(a) below).

Photo 2.1(a)

2.1.1 Swing-rope Equipment.

The inventory of equipment used for swing-rope transfer comprises: specially modified stern landing platforms on crew-boats (detailed in section 2.1.2); specially modified boat landing platforms on offshore installations and accommodation vessels (detailed in section 2.1.3); and the swing-ropes themselves. The latter are large diameter ropes, in many cases specially knotted at approximately 2’ intervals, which are suspended so as to permit transfer personnel to swing from a boatlanding to the stern of a crew-boat or vice versa. Photo 2.1.1(a) shows



swing-ropes deployed on an offshore installation boatlanding in readiness for personnel transfer operations. Swing-ropes can be supplied by specialist manufacturers

(e.g. Billy Pugh - https://www.billypugh.com/products/line-and-ropes/ropes/)

or by marine chandlers who will prepare swing-ropes to a client's particular specification. Swing-ropes supplied by Billy Pugh have an offshore design life of 3 years. There are no apparent specific standards to which these ropes are manufactured, apart from an oblique reference to 'swinging ropes' in the 2011 Germanischer Lloyd "Guideline for Personnel Transfers by Means of Lifting Appliances" a copy of which is provided as Appendix 11. Swing-ropes are not required to conform to any man riding equipment regulations. However, these ropes and attachment shackles are rated for much higher weights than would be applied during swing-rope operations.

Some boatlandings equipped for swing-rope transfer feature twin-rope systems, with inboard and outboard ropes at each position. The inboard ropes are used for the transfer from the crew-boat to the boatlanding platform, allowing the person to plumb over the landing platform. The outboard rope is used for transfer from the boatlanding platform to the crew-boat, allowing the person to better plumb over the crew-boat swing-rope landing area. These twin ropes may be connected above the point at which personnel hold on, so that if for example, a person swings from the boatlanding platform to the crew-boat, but does not manage to land, that person can be pulled back towards the boatlanding platform by remaining personnel, using the inboard swing-rope.

- Photo 2.1.1(a) shows a single swing-rope configuration.
- Photo 2.1.1(b) shows a twin-rope system (with un-knotted outboard swing-rope).
- Photo 2.1.1(c) shows a twin-rope system with a tagline connecting both ropes.

As referenced in the risk assessment notes (See Appendix 2) there is anecdotal feedback from offshore, and evidence from incident reports that the knots on the ropes, whilst preventing unintentional sliding down the rope, also cause problems in that personnel are not able to slide down to meet a landing deck level below them, and instead have to fully let go of the rope. Accordingly, some swing-ropes, and in particular, the outboard rope with twin-rope systems, are not knotted, and allow personnel to slide down the rope.

A video example of a twin swinrope system in use, with unknotted outboat rope, and personnel poition on the boatlanding-side rope to recover a person back to the boatlanding if so required can be viewed at - https://www.youtube.com/watch?v=WGnt2P2ZDKY

Example of twin-rope system with unknotted outboar rope.

Photo 2.1.1(b)

Example of taglines between twin-ropes.

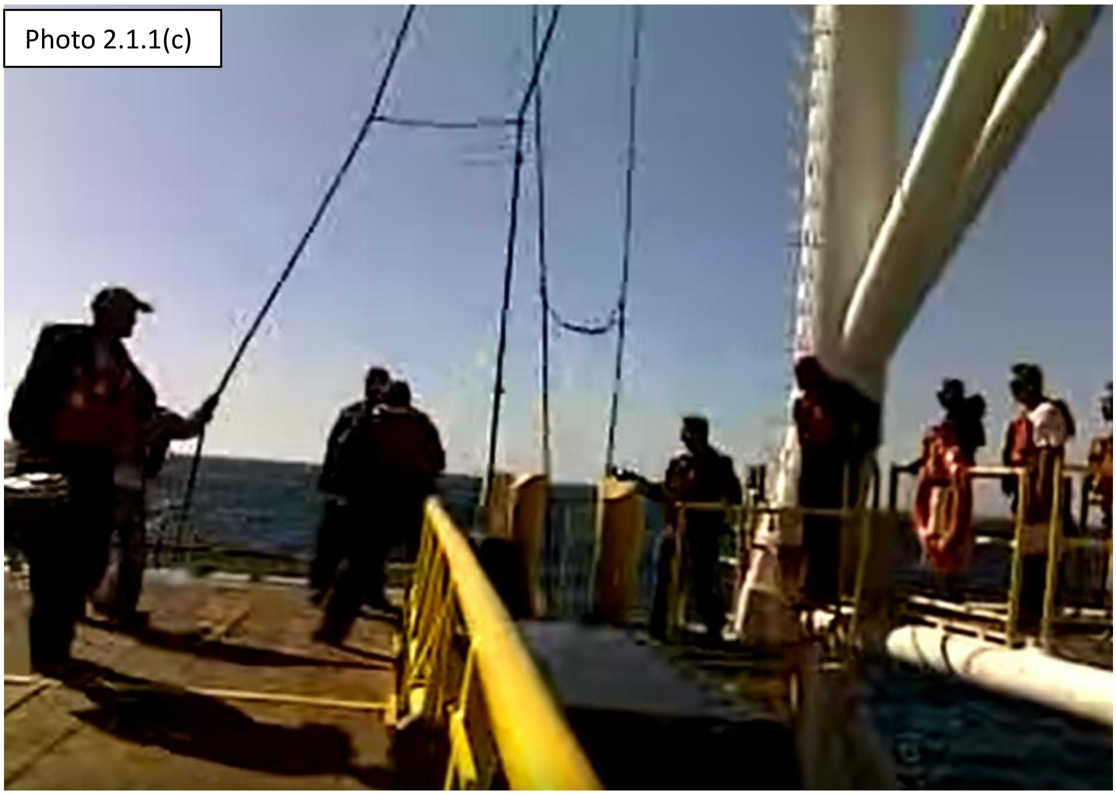


Photo 2.1.1(c)

2.1.2 Crew-boat Application.

Crew-boats that support swing-rope transfer operations are often modified to suit this application. The key special modifications which may be applied are as follows:

i. **Fendering:** Specialised fendering is applied to the stern to permit the crew-boat to make contact with the boat landings on offshore installations and accommodation vessels. (See photo 2.1(a) above)

ii. **Handrails**: Special handrails running fore/aft are positioned just inboard of the stern, to allow arriving personnel to steady themselves when landing, and departing personnel to muster when waiting to transfer. (See photo 2.1(a) above)

iii. **Lowered deck level**: It is important that the transfer personnel landing area at the stern of crew-boat is at a similar level to the boatlanding platforms that the vessel is to transfer personnel to. Crew-boats that have a main deck freeboard that is significantly higher than the boatlanding that they connect with, may have a lowered landing platform at the stern. (See photo 2.1.2(a) below).

Photo 2.1.2(a)

When positioning themselves against boatlanding platforms offshore, crew-boats will endeavour to minimise actual contact with the boatlanding structure (Offshore Installation) or the vessel hull (Accommodation vessel) so as to minimise damage to the stern fendering, the vessel hull and the boatlanding structure. Therefore, the crew-boat master will make light contact so as to position the vessel stern adjacent to the swing-rope landing area, and will then try and hover the vessel slightly off the landing area. The crew-boat therefore remains dynamic during swing-rope transfer operations as the master endeavours to maintain stern position, whilst avoiding contact. The standoff between crew-boat stern and landing platform can vary between 0m (i.e. contact) and 2m+ during swing-rope transfer operations, and the angle of the vessel can also vary from being fully 90° to almost beam-to, depending on wind and wave direction. (See photo 2.1.2(b) below).

Photo 2.1.2(b)

2.1.3 Boat Landings.

The boat landings that crew-boats transfer personnel to will fall into two principal categories:

- Offshore Installation boatlandings.
- Accommodation vessel boatlandings.

Further details are given below:

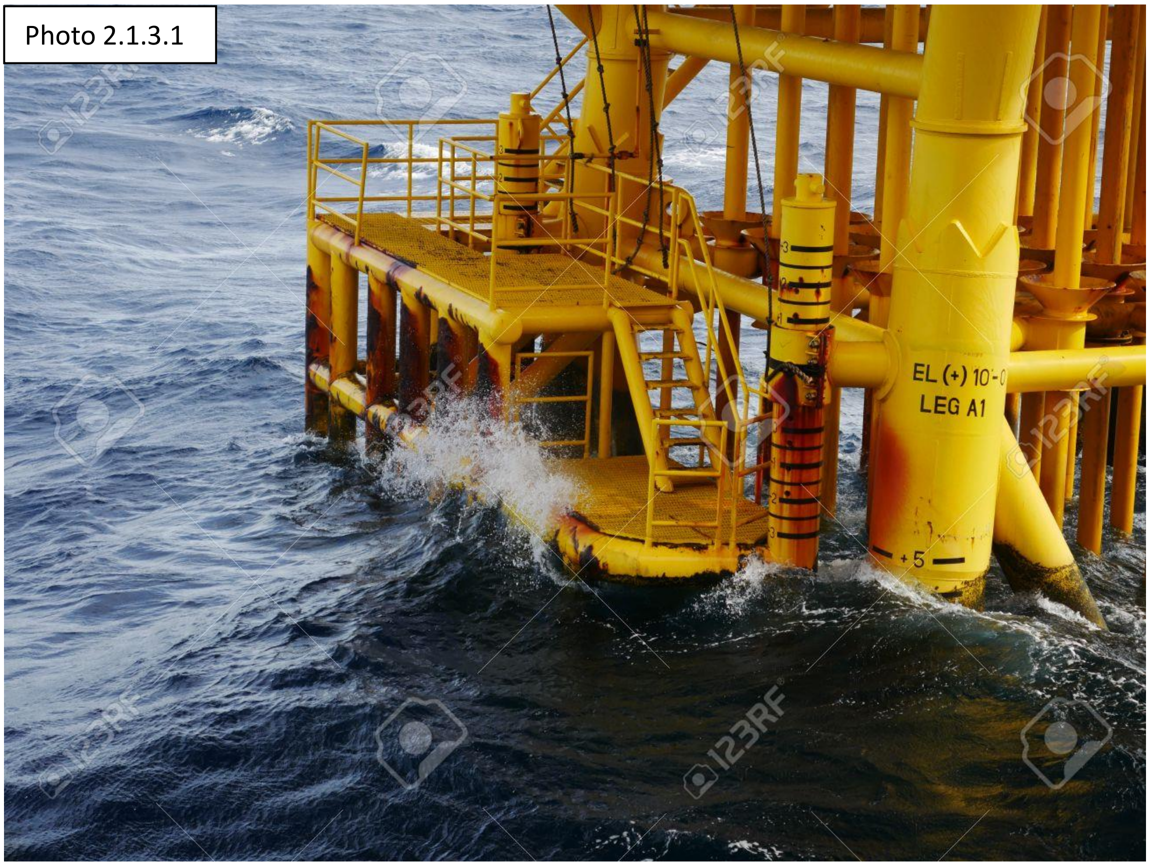
2.1.3.1 Offshore Installation Boatlandings.

Boatlandings that are used for swing-rope transfers on offshore installations will be predominantly on fixed (i.e. not floating) facilities. As such, the sea level at the boatlanding area will vary between high-water and low-water in accordance with local tidal rise and fall conditions, and the sea level variation between high and low water will itself vary between neap tide (Lesser) and spring tide (Greater) phases. In order to facilitate access from fixed boatlandings to floating crew-boats, and because minimising the height differential between the crew-boat landing platform and the offshore installation is critical to the safe management of the transfer operation (See threat 'T-12' in risk assessment – Appendices 1 & 2), some boatlandings on offshore installations are at two or more different heights (See photo 2.1.3.1).

Some boat landings on offshore installations are also equipped with ladders extending below sea level to facilitate access and egress from small boats such as fast rescue boats (FRB).

NB: When creating project-specific risk assessments covering swing-rope transfer operations, it is worth noting that the offshore boatlandings may be heavily covered in hard marine growth, which can cause abrasion injuries to casualties in the water, and damage to inflatable FRBs (see Consequence 'C4/B2/E2/B1' in risk assessment – Appendices 1 & 2).

Photo 2.1.3.1



2.1.3.2 Accommodation vessels.

Offshore accommodation vessels may include monohull vessels (some equipped with dynamic positioning), accommodation barges, and FSO/FPSO type vessels. As a general rule, the freeboard of the swing-rope boatlanding platforms on these vessels does not vary much, and matching boatlanding heights with crew-boats is not such a problem as it is with fixed offshore installations. It is to be noted however that, due to headroom constraints, the length of swing-ropes on accommodation vessels tends to be shorter than on offshore installations, and hence minimising the standoff distance between crew-boat and landing platform becomes more critical. (See threat 'T-16' in risk assessment – Appendices 1 & 2).

NB: When creating project-specific risk assessments covering swing-rope transfer operations, it is worth noting that vessels with dynamic positioning (DP) may need to cease other operations (e.g. lifting operations) during crew transfer operations. Furthermore, DP vessels may be able to create a lee during swing-rope transfer ops to minimise the dynamics of the crew-boat.

NB: It is also with noting that, when considering the unpredictable movement of the crew-boat as a risk assessment threat (see threat 'T-14' in risk assessment – Appendices 1 & 2), the dynamics of the accommodation vessel, albeit slower and with less accelerations, will add to this unpredictability factor.

See photo 2.1.3.1(a) for an example of an accommodation workbarge boatlanding.

See photo 2.1.3.1(b) for an example of an accommodation workboat boatlanding.

See photo 2.1.3.1(c) for an example of shorter swing-ropes on workboat or barges.

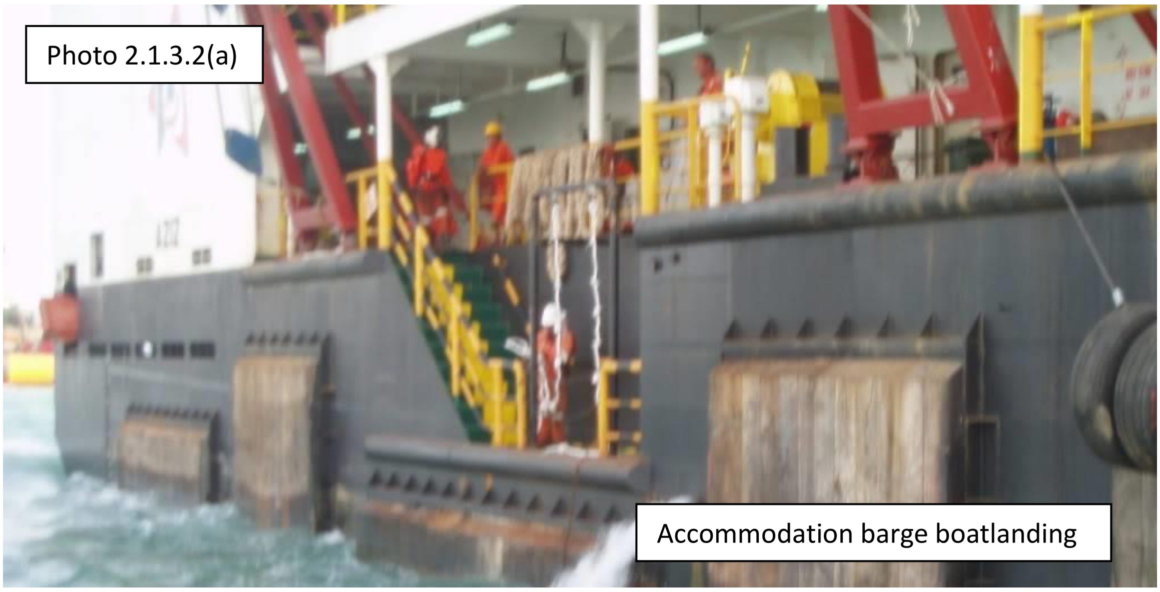


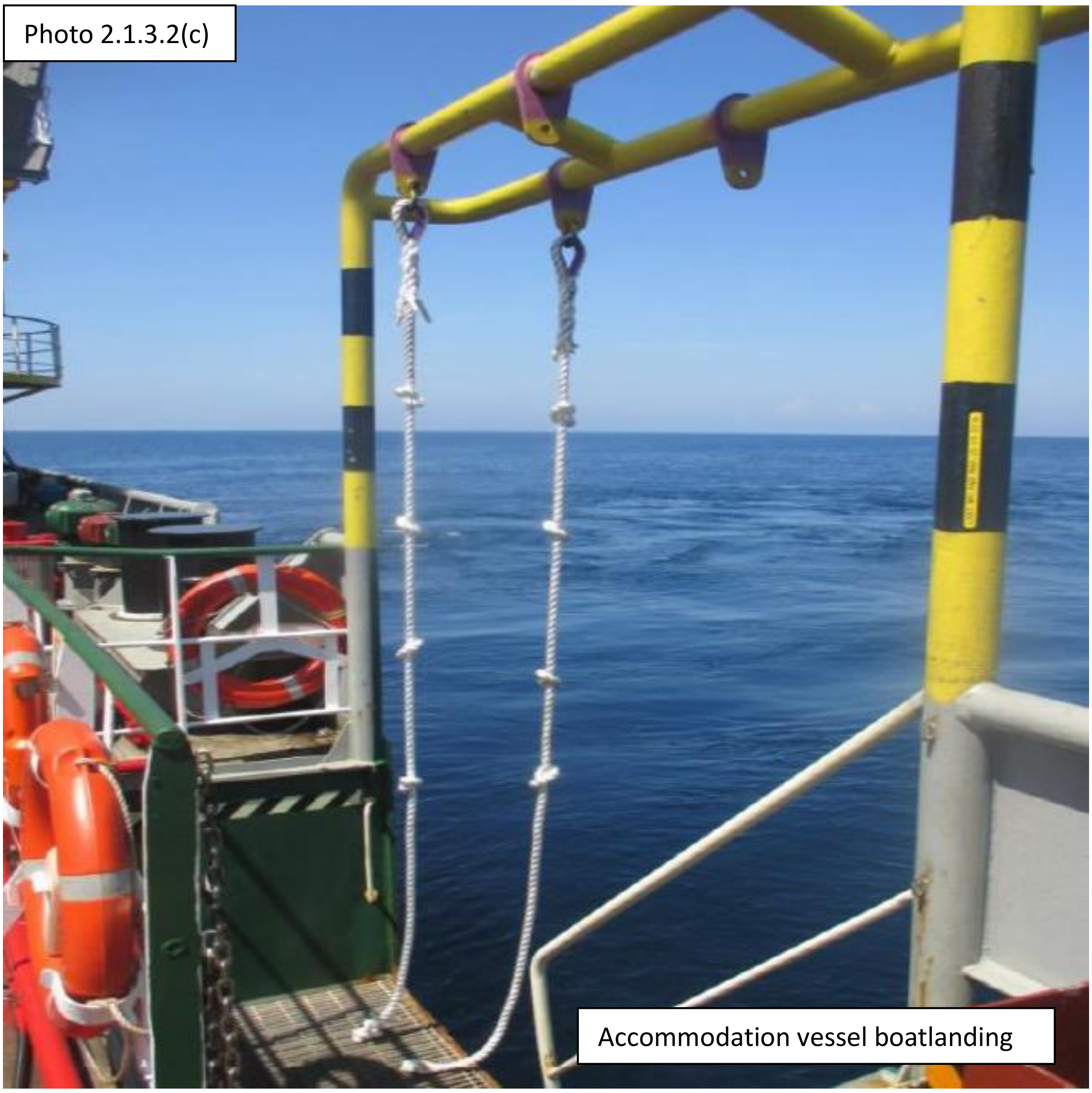
Photo 2.1.3.2(a)

Accommodation barge boatlanding

Photo 2.1.3.2(b)

Accommodation vessel boatlanding

Photo 2.1.3.2(c)



Accommodation vessel boatlanding

2.1.4 Special Equipment.

Special equipment as has been identified / referred to in the risk assessment given in section 3 (and Appendix 2) is listed below.

NB: unlike the equipment in sections 2.1.1, 2.1.2, and 2.1.3 above, the "Special Equipment" detailed in this section is NOT necessarily part of the "standard" inventory of equipment which is routinely used in swing-rope transfer operations.

2.1.4.1 Marine Motion Sensor.

A marine motion sensor installed on the stern of crew-boat to monitor heave and calculate / record seastate (HS) real time. An example is the Kongsberg SEATEX MRU5, details of which are given in Appendix 6. (See BowTie Ref T1/B2).

2.1.4.2 Sea Level / Seastate Sensor.

A Sea level and wave height monitoring and recording system installed at the destination boatlanding, which can calculate Seastate (HS) and monitor sea level. An example is the General Acoustics LOG_aLevel system, details of which are given in appendix 7. (See BowTie Ref T1/B2 and T12/B2).

2.1.4.3 Distance Measurement System.

A distance measurement system with recording facility installed on the stern of crew-boat to monitor distance between crew-boat and destination landing platform (i.e. the gap between vessel and landing platform that transfer personnel will need to cross on the swing-rope). An example is the Range Guard Distance Measurement System, details of which are given in Appendix 9. (See BowTie Ref T16/B2)

2.1.4.4 Jason Cradle.

The Jason's Cradle MOB recovery system is designed to retrieve people quickly and horizontally from the water, thus reducing the possibilities of "dry drowning". Details are given Appendix 8. (See BowTie Ref C3/B4).

2.2 Safety Standby (FRB) Boat Cover.

Swing-rope personnel transfer activities are commonly categorised as 'Overside Working' under the facility safety management systems that apply offshore. As such, it may be that the applicable procedures and permit to work system at the worksite will require a fast rescue boat (FRB) to be in immediate readiness to deploy on the event of a man-overboard situation. This may require a safety standby vessel to hold close station, or for the crew-boat from which personnel shall be transferred, to be equipped with a Fast Rescue Boat (FRB).

2.3 Regional Use.

The use of swing-ropes as a means of personnel transfer is prohibited by a good deal of the global offshore oil & gas industry on safety grounds and is plainly impractical in regions where metocean conditions are not benign. The use of swing-rope transfer is however still used in the following locations:

- Gulf of Mexico (US)
- South East Asia / Australasia
- India.
- West Africa.
- Persian Gulf

2.4 Safety Statistics.

2.4.1 Available Study Information.

Although statistics on *helicopter transportation and **basket transfer in the offshore industry have been researched, collated and made available, no such collated statistics are apparently available specific to swing-rope transfer. Therefore, no statistical safety performance information has been factored into this study. Examples of sources of helicopter and basket transfer safety performance statistics are given below.

*IOGP - Safety performance indicators – Aviation – 2013–2016 data.

**DNV - RISKS OF MARINE TRANSFER OF PERSONNEL OFFSHORE.

2.4.2 General review of Available Incident Information.

Available LTI reports, safety alerts and casualty reports relating to offshore swing-rope transfer operations have been researched, with a view to contributing to the hazard identification and risk assessment process detailed in section 3 below. These incident reports and alerts are collated in Appendix 3 and are summarised in the table below.

NB: Available incident evidence is limited, and the below Incident Summary Matrix represents qualitative research (i.e. to gain insights into the kinds of threats / consequences associated with this technique) rather than quantitative research (such as would provide meaningful statistical evidence about the number / frequency of such incidents).

Source	Incident summary	Factored into Bow Tie
Apache	While swinging from boat to platform, the contractor slipped from the rope and went into the water.	Yes
Apache	While swinging from boat to platform the swing rope parted and the contractor grabbed onto the boat tire.	Yes
Apache	Contractor jumped across from the platform to the boat without using the swing rope.	Yes
Apache	While swinging from platform to boat the contractor struck lip of jump deck on vessel and fell into the water	Yes
Apache	Employee sustained knee injury when he landed on jump deck of vessel	Yes
Apache	While mooring, the contractor tugged on the swing rope to test it and the pad-eye welded to the beam of the platform parted, causing the swing rope and chain to go into the water	Yes
Apache	An inspector was swinging from the boat to the platform and didn't have a good grip on the rope and he fell backwards onto the tires and back deck of boat	Yes
Apache	While swinging from platform to boat, the distance between the two expanded and the contractor fell into the water	Yes
Apache	Government investigators are looking into the February 17 death of an offshore worker from Breaux Bridge, Louisiana. Joseph Bruno died while working on an Apache offshore natural gas production platform south of Lake Charles. He was a fire watcher for H.I.S. Fire and Safety Company. The company had been hired to do maintenance on the Apache Corporation platform. Bruno was on a swing rope going from a vessel to Platform WC 575A when he fell into the Gulf of Mexico. He was wearing a flotation device and was alive when his co- workers pulled him from the water. However, after the rescue he became unresponsive and died while on the platform. The accident is under investigation by Apache Corporation and by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE).	Yes
BSEE	During a swing rope transfer in the Gulf of Mexico, a contract operator did not land to the platform from a boat and fell into the water. The contract operator was quickly recovered by the vessel crew and was transported back to the manned facility. The injured contract operator was diagnosed with a torn ligament in his elbow that required surgery.	Yes

BSEE	A contract operator fell into the water during swing rope transfer between boat landing deck and vessel. The injured was diagnosed with abrasions to the left leg and a strain to his lower back.	Yes
BSEE	While transferring from a platform to a boat via a swing rope, an employee hit his knee on the top of the stern bulwarks	Yes
BSEE	A contract employee was swinging onto the platform from a crew boat. He landed off balance on the platform boat landing and twisted his left knee, possibly tearing ligaments. The boat landing and swing rope were in good condition and the seas were calm. The employee apparently used poor judgment in positioning his body while using the swing rope to board the platform.	Yes
BSEE	A contract worker was transferring between the platform and M/V using a rope swing. The vessel was apparently rising and falling with the passing swells. When he swung over the railing, the vessel was riding in a trough which momentarily increased his height above the deck. Unable to slide down the knotted rope, he released his grasp on the rope and fell to the deck sustaining a compound fracture to his right ankle.	Yes
BSEE	Inspection safety flash.  Poorly maintained swing-rope lug.	Yes
Marinesafe	A recent High Potential Incident where an offshore crew fell overboard during swing rope transfer from a platform boat landing to the deck of a crew boat. The MOB incident occurred during period of darkness in moderate sea states. A crew boat had positioned itself at the boat landing of an offshore platform and 5 Offshore crew members were in the process of transferring across from the boat landing to crew boat stern deck. Two marine crew members were in attendance at the stern of the crew boat to provide assistance as per normal procedure. Three of the offshore crew had made the transfer safely and the fourth was in the process of swinging over to the deck. Due to a combination of improper swinging technique and sudden heave movement on the boat, the crew member only partially landed on the landing stage on the crew boat. He released his grip on the swing rope prematurely and fell into the water before the marine crew in attendance could get a hold of him. (Refer to pictures further below which illustrate the position of the IP just prior to falling overboard.	Yes

	Whilst floating in the water, the offshore crew struck his head and hands against the barnacle/sea growth on the boat landing. The IP (Injured Person) suffered abrasions to his hands and a cut to his head, the latter injury subsequently required stitches. The IP eventually managed to board the platform safely via the sea ladder before being evacuated by crew boat.	
Petronas	A person fell into the sea when he failed to transfer from the accommodation work boat to a Fast Crew Boat (FCB) using swing rope. While swinging, a slight swell approximately 0.8 meter lifted up the FCB. He was still holding on to the swing rope with his right hand but his leg right leg got entangled with swing rope which then caused him to fall into the sea. Life buoy was deployed and he was successfully rescued. He was sent to medic on board for assessment and no injuries were found. Stop work policy was immediately implemented and stand down The rest of crew change were transferred the next morning. Investigation has commenced.	Yes
Incident Share	Employee utilizing swing rope in offshore California swinging on to platform from vessel, standard swing not rough seas, misjudged the swing; he was caught between vessel and platform causing a crushing injury to his pelvis.	Yes
Incident Share	Davit type swing rope set up, davit not engineered for design and employee fell onto grating and davit fell into the gulf. All fields should look at their swing rope systems to ensure that they are designed correctly.	Yes
Incident Share	Swing Rope incident personnel transferring and fell between vessel and landing sustained a crushing injury.	Yes
Incident Share	Swing Rope, performed weight test and swing rope collapsed, no injury occurred.	Yes
BSP Newsflash	A construction crew was transferring via swing rope, from an anchored Accommodation workboat to a crew boat. One person did not transfer successfully and slid down using the swing rope into the sea. The Workboat and Crew-Boat, Boat Landing Officers (BLO) deployed the life buoys with line which the person held on in addition to the Rigid Lifejacket being worn. A support vessel in the vicinity rescued the person from the sea instantly. The person was safely returned to workboat and medical examination was carried out.	Yes

2.5 Industry Guidance.

Guidance notes, procedures and HSSE documents relating to offshore swing-rope transfer operations have been researched, with a view to contributing to the hazard identification and risk assessment process detailed in section 3 below. These documents are collated in Appendix 4 and are summarised in the table below.

Source	Ref.	Document title
IMCA	IMCA SEL 025 Rev. 1, IMCA M 202 Rev. 1	Guidance on the Transfer of Personnel to and from Offshore Vessels and Structures.
OSHA Academy	Offshore Oil & Gas Safety II	Study Guide.
BP	BP U.S. Pipelines and Logistics (USPL) Safety Manual	Boat and Vessel Safety
IADC	HSE Bulletin	Correct Usage of Rope Swings
Energy XXI Gulf Coast, Inc. (EGC)	Safety Alert Bulletin	Personnel Transfer by Swing-rope.
Sonoco	SEMS 9-10	Swing Rope Transfers.
Fieldwood Energy	JSA	Swing Rope Transfer.
Williams Offshore	Version 1	Williams Offshore Contractor Safety Handbook/
Ardent Services	O-SS-SPP-0019	Offshore Safety, Personnel Transfer and Working Near or Over Water.
Repsol	90-00023GU	Offshore Vessel Vetting Process
Step Change in Safety	Marine Transfer of Personnel	Offshore Personnel Transfer Guidelines
TDI Brooks	Safety Management Manual	Small Boat Operations
IAGC	Presentation	Passenger Transfer at Sea

2.6 Video Clips.

To get an appreciation of swing-rope transfer operations as they occur offshore, under a range of weather conditions and transfer scenarios, it is worth viewing Youtube video clips that have been posted both by offshore personnel and by training organisations. A list of recently available video clips is given in Appendix 5.

3 TECHNIQUE RISK ASSESSMENT

A generic BowTie risk assessment for swing-rope personnel transfer was undertaken. The details of the method used, the input used, detailed notes on the risk assessment and the output in terms of barriers (Control measures) are given in this section. This BowTie risk assessment is the key element of this offshore personnel transfer technique evaluation, and a detailed review of the risk assessment is given in section 4 below.

NB: If a high-level review of this document and the Swing-rope transfer technique only is required, then this section 3, and appendices 1 and 2 could be skipped or briefly reviewed for context.

3.1 Risk Assessment Technique Review.

3.1.1 Aims & Objectives.

The principle aim of the Bow Tie risk assessment given in section 3 is to break down the Swing-rope Personnel Transfer Technique into an assessment of the generic threats and consequences inherent in this transfer method, together with logical, proactive and reactive barriers so as to aid the objective evaluation of the technique in a generic context. Specific objectives of the Bow Tie risk assessment in support of this aim were as follows:

- To Provide a generic Bow Tie Risk Assessment based on a typical offshore oil & gas project application, which could form the basis of, or a guide for a project-specific risk assessment.
- To provide an overview of the efficiency and manageability of this personnel transfer technique as the basis for comparison with other available offshore personnel transfer techniques.
- To demonstrate the level of control required to provide a safe system of work.
- To provide a simple graphic method and format for exploring and communicating threats, consequences and control measures inherent in this crew transfer technique.

3.1.2 Risk Assessment Type.

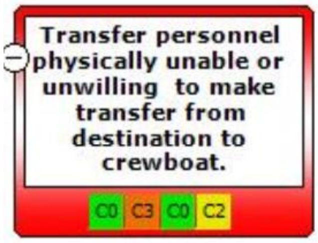
The risk assessment process used was the 'BowTie' method, and this was facilitated using Bow Tie XP software. The BowTie diagram developed is given in Bow Tie XP and PDF Format in appendix 1.

To use BowTie vernacular, the 'Hazard' used was "Offshore Crew Transfer Using Swing-rope" and the 'Top Event' was defined as "Loss of Control of a Safe System of Work". For those unfamiliar with the BowTie risk assessment method, the following introduction video on Youtube may be helpful. https://www.youtube.com/watch?v=0sz2MIaij3o

To further aid comprehension of the Bow Tie process for those not familiar with the technique, an explanation of this method of risk assessment is given in a briefing note in Appendix 10.

3.1.3 General Method.

The general method used to develop the BowTie risk assessment was to set up an appropriate 'Hazard' and 'Top Event' representing the offshore personnel transfer technique – Swing-rope - and then develop generic 'threats' (i.e. factors that could cause the top event) and 'consequences' (i.e. unwanted scenarios that could be caused by the top event). From there, proactive barriers (i.e. control measures that will prevent the 'Top Event' occurring) and reactive barriers (i.e. control measures that will reduce or prevent 'consequences' if the 'Top Event' occurs) were developed. The proactive and reactive barriers were then subjectively assessed for effectiveness (categorised as Very Poor, Poor, Good, or Very Good), and each final consequence was assessed for residual qualitative risk under the following four categories:



- People.
- Assets.
- Environment.
- Reputation.

These four categories are set out in four tabs at the base of each main consequence box given in the BowTie diagram (See example above), and a copy of the risk assessment matrix and the probability / severity method and rating system used is given below.

Risk Matrix

Reputation

		A Very unlikely	B Unlikely	C Possible	D Likely	E Very likely
0	No Impact	A0	B0	C0	D0	E0
1	Slight Impact	A1	B1	C1	D1	E1
2	Limited Impact	A2	B2	C2	D2	E2
3	Considerable Effect	A3	B3	C3	D3	E3
4	National Impact	A4	B4	C4	D4	E4
5	International Impact	A5	B5	C5	D5	E5

Risk Categories:

- No impact
- Incorporate Risk Reduction Measures
- Manage for Continuous Improvement
- Intolerable

OK Cancel

3.1.4 Context.

The BowTie Risk Assessment was developed entirely as a generic risk assessment but was based on the assumption that a typical range of crew-boat or FSIV type craft would transfer offshore personnel either to or from onshore to offshore destination facilities, or would transfer personnel from one offshore location to another. Consideration was given to the offshore destination facilities being boat-landings on either fixed platforms or on floating accommodation facilities (e.g. moored accommodation work barges or DP accommodation vessels). The threats and barriers developed assumed generally benign weather conditions and moderate tidal rise and fall. The assumption was generally made that at least three safety management systems were involved as follows:

- Crew-boat duty-holder SMS.
- Offshore destination facility duty-holder SMS.
- Transfer personnel employer SMS.

The risk assessment also confined itself to the transfer of personnel for general offshore operations purposes and did not consider the technique in the role of emergency evacuation or escape.

3.1.4.1 Top Event.

The 'Top Event' used was broad in context and followed the general BowTie principle that 'the top event is the first moment control over a hazard is truly lost, releasing its harmful potential'. The top event used was 'Loss of Control of a Safe System of Work', and the extract from the BowTie diagram is shown below relative to the BowTie Hazard (Offshore Crew Transfer Using Swing-rope).

3.1.4.2 Chaining.

Sometimes a generic bowtie is created where the threats and consequences are specified in other bowties. In this case, a threat or consequence can become a new top event in another bowtie. In this manner, several bowties will be linked, creating a chain of events. This is called chaining bowties. This technique was not adopted for this BowTie, and only one hazard and top event were used. However, when developing a project specific BowTie risk assessment of this personnel transfer method, consideration could be given to chaining the diagram to the left (i.e. making a threat a consequence) which could have the effect of exploring governing management systems. Consideration could also be given to chaining the BowTie to the right, (i.e. making a consequence a threat) which could have the effect of examining the management of the listed consequences in greater detail.

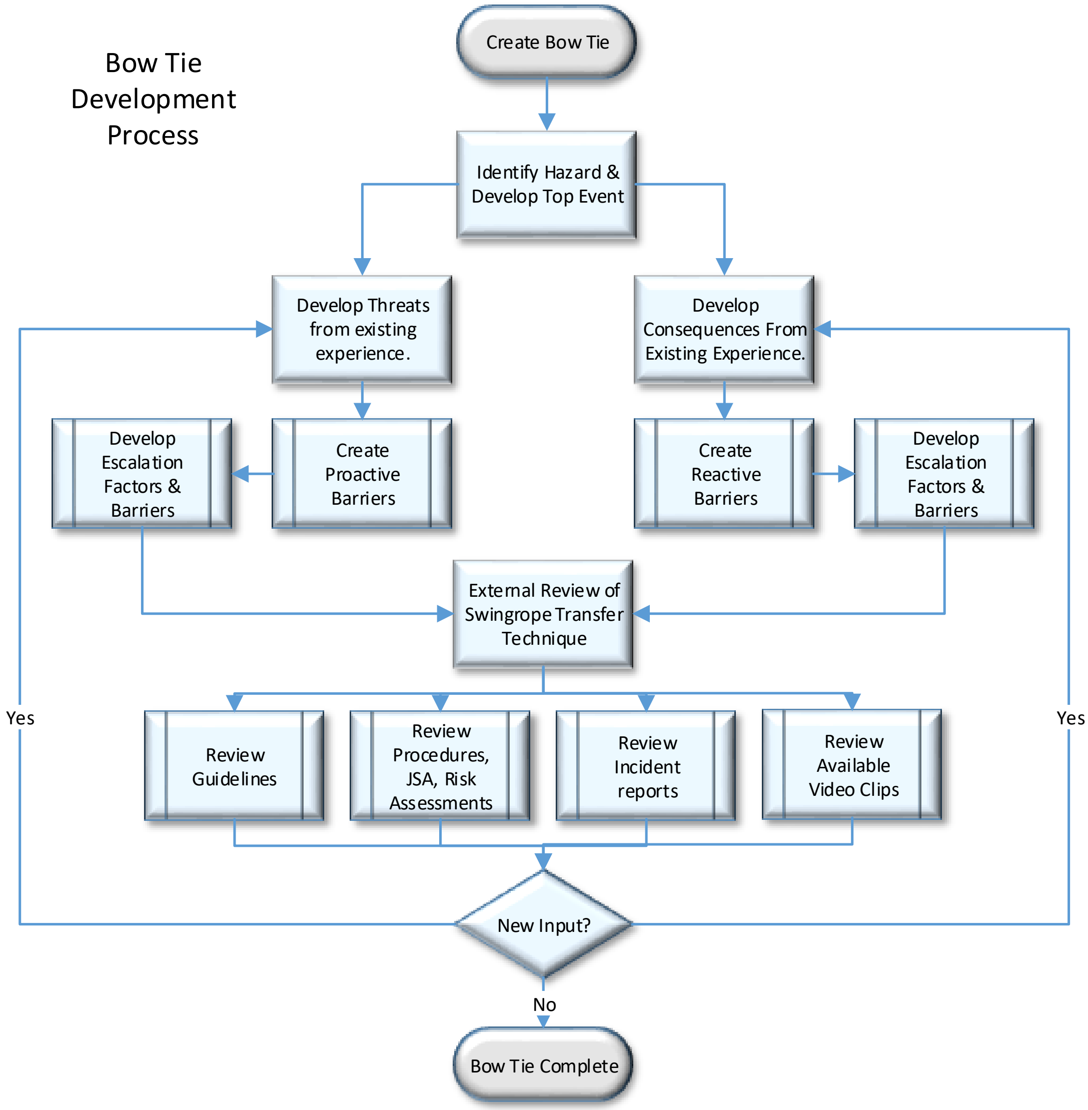
3.1.5 Degree of Abstraction.

The degree of abstraction used when developing the threats, consequences, escalations factors and barriers was 'medium' and not detailed. The intention was to produce a risk assessment which provided an overview of the generic threats and consequences inherent in this personnel transfer technique, together with logical barriers which would be required to provide as safe a system of work as may be practicable, so as to provide an overview of the workability and relative efficiency of Swing-rope transfer compared with alternative options. An additional objective was to develop a framework Bow Tie which could be used as a guide for more detailed and project-specific BowTie for this type of operation. The barriers used represent our opinion on 'best practice' and the most practical means of applying the required control measures.

3.2 Bow Tie Risk Assessment.

3.2.1 Swing-rope Technique Review Process.

In order to identify and develop the threats, consequences, escalation factors and barriers, the following process was used to develop a Bow Tie Risk Assessment.



3.2.1.1 Incident Reports.

The incident reports reviewed are listed in section 2.4.2 above and are collated in Appendix 3.

3.2.1.2 Guidance notes.

Guidance notes, procedures, JSAs and safety bulletins reviewed are listed in section 2.5 above and are collated in Appendix 4.

3.2.1.3 Video Clips.

A selection of video clips reviewed is listed in Appendix 5.

3.2.2 Threat, Consequence & Barrier Ordering.

It is common practice with Bow Tie risk assessment development to order the threats and consequences in perceived order of importance or priority from top down, and barriers in perceived order of importance or priority from the Threat or Consequence towards the top event. However, as this Bow Tie is generic, and as the prioritisation of threats, consequences and barriers may be assessed differently for specific projects and worksites, no specific prioritisation has been applied.

3.2.3 Bow Tie.

The bow tie diagram that has been developed is given in Appendix 1, in original Bow-Tie-XP, Visio and PDF formats.

3.2.4 Bow Tie Notes.

3.2.4.1 Bow Tie Reference System

Each threat, consequence, escalation factor and barrier has been given a unique reference code as follows:

Threat:	T1, T2 etc.
Threat Barrier:	T1/B1, T1/B2 etc.
Consequence:	C1, C2 etc.
Consequence Barrier:	C1/B1, C1/B2 etc.
Escalation factor:	T2/B3/E1, C3/B2/E1 etc.
Escalation factor Barrier:	T2/B3/E1/B1, C3/B2/E1/B1

3.2.4.2 Bow Tie Notes.

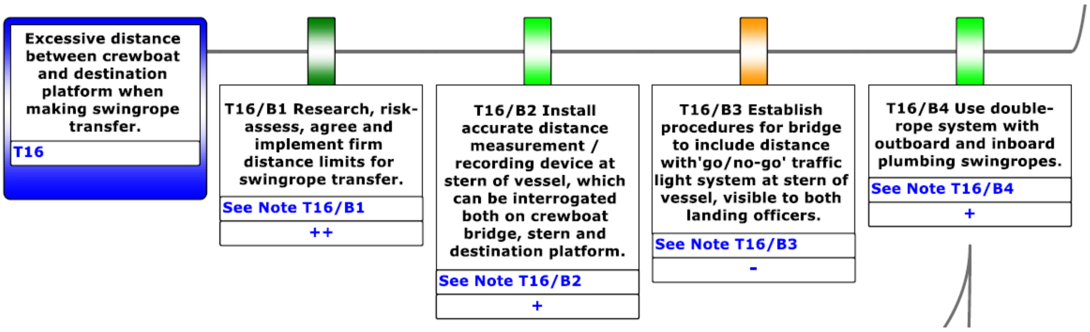
Each box in the BowTie which requires additional explanation or notes is listed in the Bow Tie assessment matrix given in Appendix 2, together with additional information, barrier efficiency comment and control measure details.

3.2.4.3 Barrier Efficiency.

The BowTie software application used (BowTie XP) allows for a qualitative assessment to be made of the efficiency of barriers. The qualitative range provided is set out in the following matrix.

Barrier effectiveness rating	Colour Code
Very poor	
Poor	
Good	
Very good	

The following extract from the BowTie diagram (See Appendix 1) shows a string of proactive barriers rated Very Good / Good / Poor / Good.



The same colour coding is used in the BowTie notes matrix given in appendix 2.

4 RISK ASSESSMENT REVIEW

A review of the BowTie risk assessment given in section 3 and Appendices 1 (BowTie diagram) and 2 (BowTie assessment matrix) above is given in this section.

4.1 Bow Tie Risk Assessment Results Review.

4.1.1 Threat & Proactive Barrier Effectiveness Review.

Of the 17 generic 'Threats' identified in the bow tie risk assessment, 9 (i.e. 53%) are described as being potentially difficult to manage due to barriers with poor effectiveness ratings. These figures would indicate that prevention of the top event itself may be difficult to manage.

4.1.2 Threats & Proactive Barriers: Quantity & Type Profile.

From a holistic perspective, the sheer number of threats (17) and of proactive barriers (77) involved in the prevention of the top event almost becomes an individual threat in its own right.

A considerable number of threats and barriers relate to the fact that several individual safety management systems are involved with the swing-rope transfer method, which can be difficult to manage.

Some of the threats and barriers involve very unpredictable events and operational circumstances, which again can be difficult to manage.

The combination of the quantity of threats and barriers, and the types of threat involved, would indicate that an extraordinary amount of management effort and coordination are required to prevent the top event.

NB: It is also worth noting that the BowTie Risk Assessment set out in this study is generic, and a project-specific BTRA would only increase the number of threats, consequences and barriers involved.

4.1.3 Consequence & Reactive Barrier Effectiveness Review.

Of the 7 generic consequences identified in the bow tie risk assessment, 5 (i.e. 71%) are described as being potentially difficult to manage due to barriers with poor effectiveness ratings. When developing the consequence barriers, consideration was given to both prevention and mitigation of consequence effects. However, due to the potential for barriers to be abused or ignored, and due also to the assurance challenges involved in monitoring and maintaining compliance with the suggested procedures, confidence is not high in the successful management of a majority of consequences.

4.1.4 Project-Specific Risk Assessment / Amplification of Management Complexity.

The generic BowTie risk assessment given in section 3, at a medium level of abstraction, demonstrates the potential complexity of safety management systems required to try to prevent the top event, i.e. to maintain a safe system of work. It is to be anticipated that a project specific BowTie, taken to a higher level of abstraction would significantly amplify the complexity of the safety management systems employed.

4.2 General Comments and Observations.

4.2.1 Multiple Safety Management Systems.

As several safety management systems are likely to be involved in the process of transferring personnel from a crew-boat to an offshore facility and back, close coordination of safety procedures and integration of management systems would need to be applied. Typical SMS systems that might apply to a single swing-rope transfer are as follows:

i. Offshore Facility Duty Holder SMS.

ii. Crew-boat Owner SMS.

iii. Transfer personnel employer #01 SMS

iv. Transfer personnel employer *#02 SMS etc

*NB: A squad of personnel transiting to / from an offshore facility may comprise employees from multiple companies.

NB: The challenges posed by the involvement and integration of multiple safety management systems is a recurring theme in the bow tie risk assessment notes matrix in Appendix 2 and represents a key weakness in the prevention of the top event and therefore the viability of this personnel transfer technique.

4.2.2 Safety Rules Incompatibility.

It may be assumed that where the swing-rope transfer technique is used in any given offshore operation, at least the offshore facility duty holder and the owner/operator of the crew-boat permit this technique. However, a growing number offshore contractors and service companies prohibit their personnel and subcontractors from using this transfer technique. This incompatibility of safety rules could lead to operational problems and contractual / commercial conflict. For example, a Marine Warranty Survey (MWS) may be required to travel offshore with a construction crew to verify the completion of a certain repair. Swing-rope transfer is the method used to access the offshore installation being worked on. The employers of the construction crew permit their personnel to transfer by swing-rope, but the employers of the MWS do not. In this scenario, the result would be: the MWS does not travel and the project is delayed.

4.2.3 Operational Constraints.

Several of the proactive (Threat-side) barriers and control measures developed with the BowTie risk assessment (See Appendix 2) involve imposing limits to variables involved in the swing-rope transfer operation. These include the following:

i. Seastate (HS).

ii. Crew-boat dynamics.

iii. Crew-boat / destination facility landing platform height differential.

iv. Crew-boat / destination facility landing platform lateral distance.

v. Daylight hours restriction.

Once applied, the sum of these limitations will inevitably impose significant limitations on the offshore operation. This may lead to either:

a) compromised efficiency of the offshore operation due to the use of this technique with control measures being appropriately applied; or

b) a tendency to ignore limits or apply soft limits, which might compromise avoidance of the top event.

NB: Another aspect of the variables involved, which is highlighted in the proactive barriers, is the criticality of accurate measurement of these variables.

4.2.4 Long Term Custom & Practice.

Operational methods offshore have a certain inertia commensurate with age when it comes to resistance to change and improvement. "We've always done it this way" and "Don't fix what isn't broken" are often given in response to a challenge to operational methods that have been used for many years and which have become established 'custom and practice' despite obvious failings and inefficiencies. From experience, this is the case with swing-rope transfer, which remains a permitted (and in some cases preferred) means of access & egress to offshore facilities with several offshore operators.

4.2.5 Lack of Available Alternative Technique.

Another reason for swing-rope transfer remaining as a permitted means of access & egress to offshore facilities is the lack of any viable alternative techniques. However, with-

i. The gradual increase in the use and availability of 'Surfer' type crew-boats,

ii. The development of 'next generation' personnel transfer crane-baskets,

iii. The rapid developments in motion-compensated gangway systems, and

iv. The development of new crew transfer innovations arriving from the offshore renewables market,

- it is anticipated that there will be an increasing migration away from swing-rope transfer techniques to alternative, more efficient and easier to manage personnel transfer techniques.

4.2.6 Risk of Assuming that Risks Have Been Adequately Managed

There is a growing realisation amongst HSSE / Risk managers that one of the greatest risks faced by an organisation is that the risk management processes in place, although diligently executed, may not in fact effectively measure, assess and manage risk, whilst that organisation assumes that the processes are adequate. I.e. we assume that all is well because existing procedures are being followed, and boxes are being ticked, but on closer examination the systems in place can fail to produce a safe system of work. Our experience with root cause analysis (RCA) suggests that root causes of incidents are often ineffective risk/safety management systems rather than systems that have not been adhered to.

4.2.7 Extraordinary Increase of Throughput.

With the same concept of a potential misapprehension that a safe system of work was in place as discussed in section 4.3.6 above, low or zero levels (i.e. acceptable levels) of LTI incidence associated with swing-rope transfer when the periodic quantity of transfers is low, might mask an inefficient safety management system. For example, if a theoretical offshore field operation has a monthly throughput of five technicians per month visiting 5 NUIs, then the monthly return transit figure would be 25. If the same field then experiences a major commissioning, revamp or decommissioning program, where a complement of 100 technicians visit each NUI daily, then the monthly return transit figure would be 15,000, representing a 600-fold increase in personnel transfer throughput. Let's say that under normal circumstances the annual LTI figure was 0.25, (i.e. one swing-rope-related LTI every 4 years), which equates to an incidence level of one LTI per every 1,200 transits which was deemed to be an acceptable level by management. Due to the sudden uplift in activities and personnel transfer throughput by x600, then the annual LTI figure statistically will rise from 0.25 LTI per year to 150, as no changes will have been made to the system of work. This annual figure may not be acceptable to management, and this unacceptable performance of the applicable SMS will have been masked by normally low activity throughput.

4.3 Operational use / Emergency use.

This evaluation document, and the risk assessment set out in section 3 above, has been based on the use of this transfer technique for operational access and egress use only. This document does not evaluate the technique as a means of evacuation from an offshore facility, as under usual standards for modes of evacuation (e.g. PFEER, ISO 15544), Swing-rope transfer would not be acceptable as amongst other reasons, the potential for impairment would be too high, and it is not possible to evacuate injured personnel via this method. Using the same standards it may however, subject to project-specific risk assessment, be considered as a means of escape.

5 STUDY CONCLUSIONS.

The remit of this personnel transfer evaluation study does not include recommending use of the technique or otherwise. However, this section draws conclusions from the review of the risk assessment for further guidance to HSSE and project managers using, or planning to use, this method of personnel transfer. These conclusions focus firstly on the left-hand side of the BowTie risk assessment (Threat Side) and the proactive barriers, then looks at the right-hand side of the BowTie (Consequence Side) and the reactive barriers, and then moves onto general conclusions.

5.1 Threats and Proactive Barriers.

To summarise the BowTie notes concerning the left-hand (threat) side of the BowTie risk assessment, the following key concerns present themselves:

- The quantity of threats (17) and the barriers (77) involved in the prevention of the Top Event* presents a very complex safety management challenge, involving considerable resources and management effort.
- Multiple safety management systems are inevitably involved, the seamless integration of which is critical to the prevention of the Top Event*, which presents further challenges to the management of a safe system of work.
- Personnel are unpredictable and may suffer unexpected physical or mental impairment to ability to undertake a swing-rope transfer and/or may act unpredictably during the process.
- Dynamic vessel movements are unpredictable, despite the barriers proposed to manage for this threat.
- Barriers setting limits on seastate, landing platform height and lateral distance differential are prone to abuse.
- Barriers involving personnel reporting impairment to physical / mental ability to undertake a swing-rope transfer are prone to abuse.

(*NB: To recall, the Top Event is 'Loss of control of a safe system of work')

5.2 Consequences and Reactive Barriers.

To summarise the BowTie notes concerning the right-hand (consequence) side of the BowTie risk assessment, the following key concerns present themselves:

- The quantity of consequences (7) and reactive barriers (28) involved in the prevention or mitigation of potential consequences of the occurrence of the Top Event (i.e. a loss of control of a safe system of work), whilst considerably fewer than the threats and proactive barriers, still presents a very complex safety management challenge, involving considerable resources and management effort.
- Again, multiple safety management systems are inevitably involved, the seamless integration of which is critical to the prevention or mitigation of the potential consequences identified.
- The 'consequences of the consequences' which would be examined by chaining the BowTie to the right for this study, have not been fully examined and assessed, and the potential severity is not perhaps fully highlighted in the risk assessment in section 3. E.g. for consequence C3 (Transfer personnel fall into water), it should be considered

that: if personnel fall into the water they would be doing so between a narrow gap between a dynamic vessel and a static structure; this gap may close (to zero i.e. impact); and the personnel would be directly exposed to the crew-boats main propulsion system at very close quarters. The potential for a fatality resulting from consequence C3 is high.

- The effectiveness of many of the reactive barriers are sensitive to impairment due to weather and seastate conditions, which can be unpredictable.
- The effectiveness of many of the reactive barriers are sensitive to impairment due to unpredictable human behaviour and the potential for personnel to ignore procedures under the operational circumstances that may present themselves.

5.3 General Conclusions.

General conclusions drawn from the swing-rope technique review and BowTie risk assessment are set out below.

5.3.1 Extraordinary & Inherently Risky Activity.

Without any detailed operational review or risk assessment, and when using general safety management norms for offshore oil & gas operations as a benchmark, the process of swinging on a rope between a dynamic vessel and a static platform, with no safety back-up and where a simple slip could prove fatal, can reasonably be described as 'extraordinary' in the context of a safe system of work, and as 'inherently risky'.

When thinking about this specific observation, it is worth considering an equivalent scenario in, for example, a shore-based factory environment.

Using a knotted rope to swing on, personnel are required to transit to and from a static platform to a reciprocal platform on part of the process machinery which is unpredictably dynamic, and collides with the static platform frequently with considerable force. The lateral gap between the two areas varies from 0 to 2m, is hazardous, and could lead to a fatality if fallen into. The vertical distance between the platform varies by + / -1m. There are no safety barriers in place, and no safety harnesses are provided. Would this situation be accepted by the workforce, permitted by the employer or meet basic Health & Safety regulations?

5.3.2 Size, Complexity and Feasibility of Management Challenge.

The quantity of threats, proactive barriers and detailed control measures that are identified in the BowTie R/A as being necessary to maintain a safe system of work represents an extensive and complex management challenge. This challenge is compounded by the fact that multiple safety management systems are likely to be involved. The reactive barriers suggested to prevent or mitigate the consequences identified, and their susceptibility to impairment, further compounds the situation to a point where feasibility of achieving ALAP within usual norms has to be questioned.

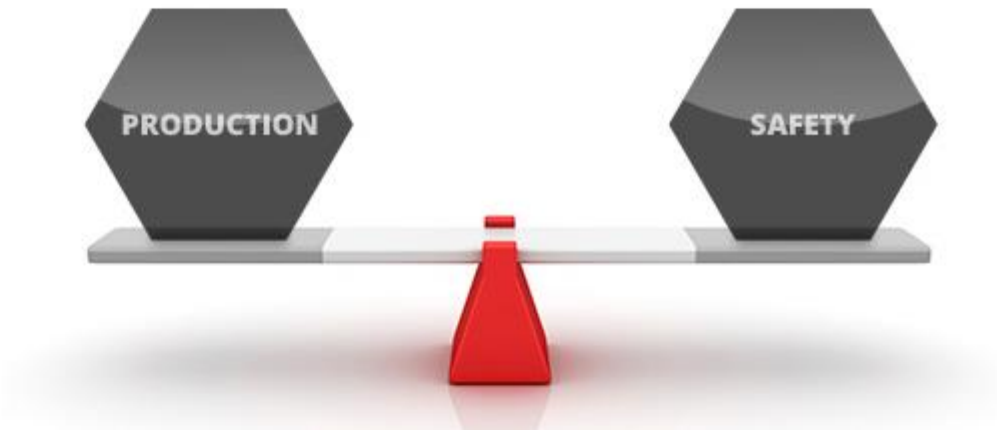
5.3.3 Relative Efficiency.

Considering:

- The amount of management time, effort and cost required to produce and implement procedures, PTW systems and bridging documentation identified in the BowTie R/A;

- The additional equipment and resources identified in the BowTie R/A;
- The tight restrictions on operational parameters, including sea-state, sea level, ambient light identified in the BowTie R/A

-then the relative efficiency of this mode of offshore personnel transfer compared with other techniques also has to be questioned. To use the 'Safety Vs Production Balance' analogy used in risk management circles, it could be said that the high degree of effort required to maintain a safe system of work, and the low efficiency (Production) associated with the technique, mark it out as being 'unviable'.



5.3.4 Technique Continuity Rationale.

The conclusions arrived at above might beg the question, "so why is this mode of transfer in use at all if it is so questionable?". The response to that question might firstly point out that companies are increasingly prohibiting this mode of personnel transfer as safety management systems become more sophisticated, and as alternative transfer techniques become available, therefore the prevalence of the technique is diminishing gradually. Secondly, the answer may be that the technique is a legacy of times in the offshore industry that had less sophisticated loss prevention systems in place, and which has endured on the basis of usual custom and practice. Thirdly, the technique may also be flying under the radar of safety KPIs and statistical assessments due to:

- Relatively low average throughput,
- Low visibility to safety managers and regulatory bodies,
- Less sophisticated SMS, reporting and data collation systems in the regions where the technique is used.

-resulting in a 'don't fix what does not appear to be broken' approach to the ongoing use of this technique.

5.3.5 Final Conclusions.

Organisations who are currently using, or contemplating the use of swing-rope transfer as a means of access and egress offshore, might be advised to consider a re-assessment of their personnel transfer operations using the generic BowTie R/A given in section 3 as the basis for a project-specific HIRA.

Whilst the remit of this document is not to recommend swing-rope transfer technique or otherwise, this technique evaluation can point to the following guidance given in section 4.2.1.2 of IMCA Guidance Note SEL025/M202 (Guidance on transfer of Personnel to and from Offshore vessels)

Quote:

4.2.1.2 Swing-rope

The use of swing-ropes is largely prohibited and is not recommended in this guidance. However, their use is permitted in a few areas. If regulations and relevant company and client procedures allow for their use for personnel transfer, great care should be taken and at least the safety aspects highlighted in the guidance in this document should apply, particularly with reference to the safety of equipment, the familiarity of personnel with the equipment and method of transfer and their fitness and ability to use it and the need for appropriate planning, control and supervision of transfer.

Unquote: